Perkins Pond Diagnostic Study Quality Assurance Project Plan

New Hampshire Department of Environmental Services (DES)
Watershed Management Bureau
Biology Section

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Wolfeboro, New Hampshire

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A3 Distribution List and Project Personnel Sign-Off Sheet

Table A-1 illustrates the Distribution List for this project.

Table A-1
Distribution List

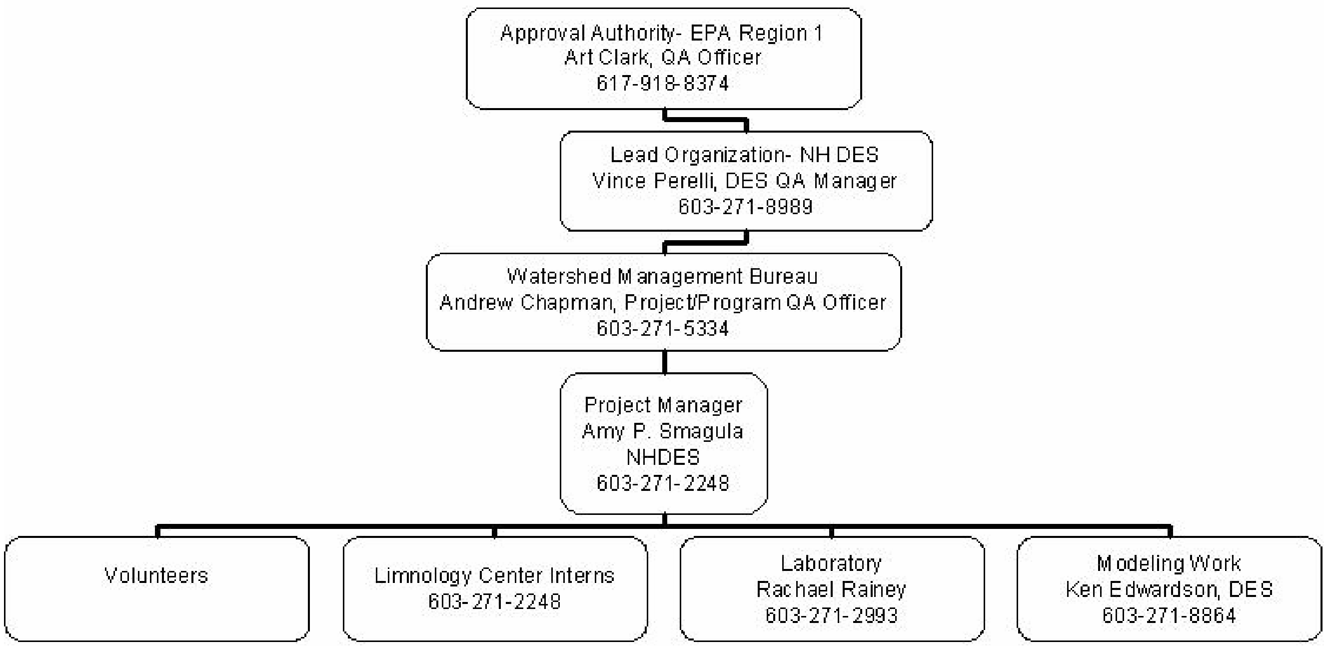
QAPP Recipients	Title	Organization	Telephone Number
Amy P. Smagula	Clean Lakes and Exotic Species Coordinator/Project Manager	DES Biology Section	603-271-2248
Ken Edwardson	Water Quality Specialist	DES Watershed Management Bureau	603-271-8864
Jody Connor	Limnology Center Director	DES Biology Section	603-271-3414
Andy Chapman	QA/QC Officer, Biology Section	DES Biology Section	603-271-5334
Vince Perelli	DES QA Manager	DES Commissioner's Office Planning Unit	603-271-8989
Warren Howard	US EPA Project Manager	US EPA-NE	617-918-1587
Art Clark	US EPA QA Officer	US EPA-NE	617-918-8374
Gary Szalucka	President	Perkins Pond Protective Association	603-863-4848
Rachel Rainey	Laboratory QA Officer	DES Laboratory Services	603-271-2993

A4 Project/Task Organization

Participation

The Perkins Pond Diagnostic Study requires the participation of a number of partners. The two major partners are the New Hampshire Department of Environmental Services (DES) Watershed Management Bureau and the Perkins Pond Protective Association. Amy Smagula, DES Clean Lakes and Exotic Species Coordinator, has the overall responsibility for conduct of the Study, including training the volunteers from the Perkins Pond Protective Association (PPPA) in sample collection and watershed monitoring. A Citizen's Advisory Committee (CAC) has been developed to facilitate the process. The CAC is represented by Amy Smagula (DES), Jody Connor (DES), Gary Szalucka (PPPA) and by other lake association and town members. DES and the PPPA will collect samples from Perkins Pond and its watershed. Figure A-1 illustrates the flow of work and the organization of the participants of this study.

Figure A-1
Organization Chart for Perkins Pond Lake and Watershed Diagnostic Study



<u>Decision Makers and Data Managers</u>
DES will be responsible for data management, data analysis and watershed load modeling, report preparation, and making lake and watershed rehabilitation recommendations based on analysis and modeling. Amy Smagula is responsible for conduct of the study and production of a final report, including the QAPP development, maintenance, and distribution. Andy Chapman is QA Coordinator for the Limnology Center Laboratory and this project. A team of Bureau staff, including Amy Smagula and Ken Edwardson, is responsible for data analysis and watershed load modeling. Amy Smagula, Jody Connor, and Ken Edwardson are the leads for data interpretation, analysis, and modeling. Quality Assurance issues that arise will be discussed between Amy Smagula and Andy Chapman, and communicated to the EPA through Andy Chapman.

<u>Data Users</u>
All data that meet QA/QC requirements will be entered into the DES Environmental Monitoring Database (EMD), and made available on the DES website. Data users include DES (for model calibration, analysis, report preparation, and formulating recommendations), Perkins Pond Protective Association and the Town of Sunapee (use and implementation of the recommendations for planning and implementation purposes), and the EPA (for confirmation of adherence to QAPP, and for populating their database with information obtained from this study).

A5 Problem Definition/Background

The DES has been requested by the Town of Sunapee, the PPPA, and other watershed residents to conduct a Diagnostic Feasibility Study (DFS) for Perkins Pond. A Diagnostic Feasibility Study is the evaluation of a lake and its watershed to pinpoint sources of elevated nutrient additions to the receiving waterbody, and to make recommendations for remediation to lessen nutrient inputs and impacts to the waterbody. DES has agreed to perform the study, with local assistance.

Much of the Perkins Pond shoreline is densely developed with small lots, and there has been growing concern that old and poorly functioning septic systems may be causing an accelerated rate of eutrophication in the pond. A proposal for a bond issue to extend town sewer to Perkins Pond residents has been presented to Sunapee voters four times, in 1999, 2000 (twice), and 2001, and failed each time.

DES met with the newly formed Perkins Pond Citizens Advisory Committee (PPCAC) on February 26, 2003. The goal of this meeting was to discuss the perceived problems with the pond, and to prioritize the purpose and outcomes from the DFS.

Based on the recorded meeting notes, the primary desired study outcome is to conduct an analysis of the watershed to determine the water quality benefits of extending the Sunapee sewer line to the Perkins Pond shoreline, and to evaluate existing and future land use under various build-out scenarios and septic system conditions for contributions to the phosphorus loading to the pond. The PPPA has been actively monitoring Perkins Pond and its watershed since 1987 through the New Hampshire Volunteer Lake Assessment Program (VLAP). The data collected throughout this time period generally indicate that the lake, from the perspective of Total Phosphorus, Chlorophyll-a, and Clarity trends, is in a stable state with regards to water quality and trophic condition. The 2003 VLAP report, containing the historical data, can be found at *http://www.des.nh.gov/wmb/VLAP/2003/perkinspond.pdf.*

A6 Project Task/Description

The goal of the DFS is to estimate phosphorus (P) loadings to Perkins Pond through the use of models to determine the primary watershed source of this nutrient to the pond, particularly focusing on septic system inputs as a possible leading source of P loading. Phosphorus is the limiting nutrient in Perkins Pond that controls primary productivity or algae growth. Algae growth is the primary factor determining water clarity and suitability for swimming, boating, other in-lake recreation activities and aesthetic enjoyment.

To accomplish P load modeling for nonpoint source load estimates, the Generalized Watershed Loading Functions (GWLF) model developed at Cornell University will be used, with an Arc View GIS model paramaterization module developed at Penn State (known as AVGWLF). The model relies on land use categories, runoff curve numbers, and event mean concentrations together with other watershed parameters to estimate monthly streamflow and phosphorus loadings in both stormwater and groundwater discharge components. The model data input requirements are provided in the table in Appendix A (parameters shaded in light gray are secondary data, and will not be directly measured in this study, but for which set model variables will be used). Models will be calibrated through actual field measurements within the Perkins Pond watershed. Once estimates of P loading are modeled for current conditions, estimates for P loading under future development and land use scenarios will be modeled using AVGWLF.

Specifically, the AVGWLF model will be used to estimate P loadings under current and alternate future scenarios to estimate the beneficial effect of sewering lakefront lots, and of other land use controls and management practices, including zoning and best management practices for nonpoint source control of P loadings. Specifically, P loading will be estimated for the following future scenarios:

1) Full-time occupancy conversion of all shorefront lots already developed, with Sunapee requirements for septic system upgrades to obtain an occupancy permit.
2) Full-time dwelling construction on all shorefront lots suitable for building, based on Sunapee zoning and building codes.
3) Subdivision at maximum density and full-time dwelling construction on all land suitable for building in watershed as a whole, based on Sunapee zoning and building codes.
4) No municipal sewers for shorefront lots, no nonpoint source BMPs, and build-out in the watershed to the extent allowed by soil conditions and existing Sunapee zoning;
5) Municipal sewers for shore-front lots, no nonpoint source BMPs
6) Build-out in the watershed to the extent allowed by soil conditions and existing Sunapee zoning; Municipal sewers and nonpoint source BMPs for shorefront lots, and targeted conservation easements in the watershed.

To estimate nutrient loading from septic systems and from runoff from nearshore lots with direct drainage to the pond, detailed estimates of septic system P loading and of wet and dry weather P loading from land use will be made through field measurements in the lake and watershed. The map in Appendix B shows sample locations throughout the watershed (triangles specify year-round tributaries, diamonds indicate seasonal tributaries, octagons indicate locations of groundwater and Interstitial Pore Water (IPWS) sampling). These data will be used to calibrate the AVGWLF model input parameters for these variables.

To estimate septic system TP loading, we assume that all hydraulic loading from shorefront lot septic systems discharges into the pond as groundwater seepage the same year it is added to the system. For shorefront lots, a detailed septic system and occupancy survey will be conducted lot-by-lot to evaluate the adequacy of existing septic systems relative to occupancy, and nearshore groundwater seepage will be measured using seepage barrels (for hydraulic loading) and interstitial pore water samplers (for interstitial pore water P concentration). These data will be used to calibrate the AVGWLF model input parameters for these variables.

The project goal is to provide Sunapee decision-makers with data and information about land use and sewer system extension through model predictions for each of the three scenarios listed above. Recommendations will be made for septic system and occupancy management for the scenario in which shorefront lots are not sewered. Recommendations will also be made for nonpoint source BMPs to reduce TP loading, especially for residential/recreational use of shorefront lots.

The management goal will be to reduce or maintain present levels of P loadings to the pond to maintain the existing trophic status classification. This information will assist the town in

evaluating development and sewering scenarios in the Perkins Pond watershed so as to prevent increased phosphorus loading and maintain a stable trophic state and stable water quality in Perkins Pond.

The tasks associated with this project will focus on:

I. Obtaining field data and secondary data to calibrate the AVGWLF model,
II. Calibrating the AVGWLF model with both real data from the Perkins Pond watershed, as well as with fixed variables from the model software
III. Running the AVGWLF model for current day and projected future scenarios detailed above
IV. Preparing the report and recommendations for the PPCAC and the Town of Sunapee.

Each of the tasks is described below in detail.

Please note: This Perkins Pond QAPP is being submitted for review and approval after field monitoring has begun. Due to the nature of this study, and the immediate need for the town and lake association involved to have data to make a determination about future planning and budgeting for the recommendations of this study, it was imperative to move forward with field sampling before the QAPP was approved. Additionally, DES was working to identify an appropriate modeling platform that would perform the desired functions for the current day and future scenarios needed for this study, so that was also a cause of delay in submitting the QAPP for review. Because field and laboratory studies of this nature were completed in the past by this Project Director, including the Rust Pond Study for which a Project Specific QAPP was approved without needs for significant edits, we are confident that the data collected under this Perkins Pond study was collected in a rigorous and quality manner, and that DES Limnology Center and Laboratory Services SOPs were followed throughout sample collection and analysis, thereby further ensuring quality data. End users of these data and the information generated from this study will certainly be made aware that the field study was conducted prior to QAPP approval, but that DES feels that the data are valid and of indisputable quality. We respectfully request that EPA retroactively approve this document based on this information.

Task I. Field Data Collection and Secondary Data Collection

The table in Appendix A lists the data needs, characteristics, range of minimum and maximum values expected to be used in this study, and the units for each parameter. These data consist of both field data from the Perkins Pond watershed that will be collected to calibrate the model, as well as secondary data obtained from other sources or from default values provided in the AVGWLF Model manual (shaded in light gray).

A. Field Data Collection

Field data will be used for model calibration and verification. Parameter ranges selected in the model will be based on those observed in the field, if applicable, and load estimates predicted by the model will be verified by comparison with the estimated nutrient load derived empirically from field data collection for present day conditions in the watershed. Field data collection will take place from June 1, 2004 through May 31, 2005.

(Note: For each field and/or laboratory sampling and monitoring task listed below, all field and laboratory protocols will follow the most recent editions of the DES Limnology Center and Laboratory Services Standard Operating Procedures to ensure adherence to Quality Objectives and Criteria set forth in guidance documents from these two laboratories. These manuals are available in both hard copy and electronically upon request)

A-1 Lot-by lot sanitary survey

Includes an interview with the property owner to obtain the following data:

a. Building occupancy (# of months per year occupancy, and # of people)
b. Number of bedrooms
c. Plumbing fixtures, including toilets, washing machines, sinks, dishwashers, water softeners
d. Septic tank size: from DES records and from interview
e. Leach bed size and location: from DES records and from interview
f. Septic system problems/ maintenance history (from interview and observation)
g. Leach bed age/ installation date
h. Map and categorize lot land use and area
    - impervious – buildings
    - impervious – roadway
    - impervious – heavy foot traffic
    - maintained - lawn
    - natural – vegetation

A copy of the sanitary survey form is included in Appendix C. This phase of the project will take place during the summer of 2003 through 2005.

To estimate detailed TP loading for shorefront and nearshore lots

a. Estimate anthropogenic TP loading to Perkins Pond from sanitary systems (Ja) using the following equation from P.J. Dillon's Lakeshore Capacity Model (this task will be carried out in winter 2006):

Ja = 0.8 (or 0.5 if no dish washer) X 10^6 mg TP X # capita years at lake X (1-Rs)

Usage = days of occupancy at cottage/house per year

Rs = retention capacity of system

- for systems with no approved plan on file with DES Subsurface Unit, use Rs = 0 for systems that are recently approved and in compliance with current Subsurface Standards use Rs =1

- for holding tanks use Rs = 1
- for approved systems with soil information, determine Rs value based on bed grain size (Table 29 in Lakeshore Capacity Study Guide)

b. Estimate TP loading for lots with direct surface drainage to Perkins pond using the AVGWLF model, calibrated using loadings estimated in B(a) above.

A-2. Water Quality Sampling

1. Routine Tributary Monitoring- place staff gages and level loggers at each year-round inflow and outflow of Perkins Pond. Conduct weekly flow measurements and staff gage readings, along with Total Phosphorus sampling (and seasonal dissolved phosphorus sampling) on randomly selected days, to determine a stage-discharge relationship through regression analysis for hydraulic loading to pond. Total phosphorus concentrations will be used to calibrate GWLF model, and empirical estimates of TP loading will be used to verify the GWLF model.

2. Wet Weather Monitoring- to be conducted three times during the timeframe of June 1, 2004 through August 31, 2005 (note that the timeframe for wet weather sampling is extended beyond the May 31, 2005 date for other monitoring as these events are unpredictable and may require a larger window to obtain adequate samples). The goal of this sampling is to collect samples of the first flush, rising limb, near peak, and falling limb for each of three types of storm events (summer thunderstorm, long soaker, short low intensity storm) at each tributary. Flows and stage will be measured, and P samples will be collected at each specified point during each storm.

3. Groundwater Monitoring- to be conducted during open water conditions on Perkins Pond. Install seepage meters in seven locations of the littoral zone of Perkins Pond to monitor groundwater seepage and recharge zones in areas of high (n=5) and low (n=2) density development. Collect groundwater measurements (volume) and interstitial pore water samples (TP concentration) on a weekly or bi-weekly basis from June 2004 through November 2004 and April 2005 through May 2005 to estimate groundwater TP inputs to calibrate GWLF model

B. Secondary Data Collection

Secondary data are those data that are derived from other sources, either through field collection by other agencies or bureaus, or through maps and empirically derived data.

B-1 Estimated TP Loading from Land Use Practices

TP loading from shorefront land will be mapped during the lot-by-lot survey using literature-derived TP export coefficients (this task will take place in fall 2005). These data will be entered into ArcView to determine aerial extent of each type of land use. Arial extent of each land use type will be multiplied by its representative P export coefficients to estimate loading for each land use.

Next, land cover analysis for the rest of the watershed will be performed using LandSat 30M pixel coverage, orthophotoquads, or other documented method of estimating land cover. Land cover/land use estimates will begin with the 2001 New Hampshire Land Cover Assessment created by the Complex Systems Research Center at the University of New Hampshire (M:\GISDoc\Granit\nhlc01.html, http://www.granit.sr.unh.edu/cgi-bin/load_file?PATH=/data/database/d-webdata/nhlc01/nh/nhlc01.html). Recognizing that the base data for the 2001 Land Cover Assessment is 30m pixels, the data will be refined using 1998 aerial photography, field reconnaissance, and the 2003 leaf-on aerial photographs as they become available through Complex Systems Research Center (early in 2005).

Using the land use/land cover data, general P loading for the remainder of the watershed (outside of nearshore zone) will be estimated using land cover categories and literature values for P loading.

B-2 Dam Bureau Precipitation and Temperature Data

Environmental data, including precipitation and temperature, are collected by the DES Dam Bureau at the Lake Sunapee Dam. Those data for the time period of June 1, 2004 to May 31, 2005 will be used in the AVGWLF model to calibrate the precipitation input portion of the model.

B-3 Evaporation

Evapotranspiration is determined using daily weather data and a cover factor based upon land use/landcover. This calculation is for a given watershed, and would relate to lake evaporation. Default values from the model will be used for this parameter.

B-4 Precipitation

P concentrations in precipitation will be obtained from rooftop monitoring data from the DES laboratory in Concord, NH. Data from this monitoring program are entered into the EMD. A data summary report for the period of this study will be printed, and data will be used to calibrate the model for this input parameter.

Task II. AVGWLF Model Calibration

The model will receive initial parameterization of the transport data file by generating the necessary GIS spatial coverages for land cover/land use, soils data, and elevations. The rest of the transport data file will be produced based upon site location which will determine length of day, growing season, recession coefficient, unsaturated soil water holding capacity, seepage coefficient and the sediment delivery ratio. The nutrient data file will be parameterized based on sediment and groundwater nutrient loads, septic system condition by month, point source loading by month, nitrogen and phosphorus in rural land use runoff, and nitrogen and phosphorus build-up and wash off rates in urban land use areas, and nitrogen and phosphorus concentrations in runoff from manured areas. A weather data file will be generated from a combination of the data collected by a weather station maintained by DES at the Lake Sunapee Dam.

Streamflow data from both scheduled monitoring and storm event monitoring and groundwater seepage data collected by the field study will be used to calibrate the watershed hydrologic parameters used within the GWLF model. Similar calibrations will be made using P data from streams and groundwater seepage measured in the watershed. Once the hydrologic parameters of the model are set, the model will be run to model monthly nutrient load. Monthly data outputs from the model for current day condition will then be compared with estimates calculated empirically from field measurements. The outcome of this step will determine what further calibration efforts are needed. Once the current conditions are set for the watershed of Perkins Pond, they will be used as the base for setting up the development of the build-out scenarios requested by the Town of Sunapee, the Perkins Pond Protective Association, and other watershed residents.

Task III: AVGWLF Model Runs and Outputs

Once calibrated, use the AVGWLF model to estimate average annual TP loadings for the following scenarios:

1) Full-time occupancy conversion of all shorefront lots already developed, with Sunapee zoning requirements for septic system upgrades to obtain an occupancy permit.
2) Full-time dwelling construction on all shorefront lots suitable for building, based on Sunapee zoning and building codes.
3) Subdivision at maximum density and full-time dwelling construction on all land suitable for building in watershed as a whole, based on Sunapee zoning and building codes.
4) No municipal sewers for shorefront lots, no nonpoint source BMPs, and build-out in the watershed to the extent allowed by soil conditions and existing Sunapee zoning;
5) Municipal sewers for shore-front lots, no nonpoint source BMPs
6) Build-out in the watershed to the extent allowed by soil conditions and existing Sunapee zoning; Municipal sewers and nonpoint source BMPs for shorefront lots, and targeted conservation easements in the watershed.

Task IV. Prepare Report and Recommendations

The final report will include a history of increasing development in the watershed, a summary of land use and land cover, data results from the AVGWLF modeling for present day and estimated future build-out scenarios, data interpretation, and sampling observations for both in-lake (from the Volunteer Lake Assessment Program) and watershed samples. An analysis of the accuracy of the model predictions will also be provided through statistical analyses and comparison with estimates of loading from field and empirical measurements, which will be calculated using the following equation:

Nearshore Landuse Loading + Watershed stormwater runoff from tributaries + Watershed baseflow (dry weather flow) from tributaries + Groundwater inputs (seepage=groundwater+septic system loading) + Direct bulk precipitation + Wildlife contributions (where appropriate) + Internal Loading from sediments(where appropriate) - Outflow – Transfer to sediments (where appropriate)= 0

A series of recommendations will be made to the PPPA, PPCAC, and Town of Sunapee based on the outcomes of the modeling scenarios and data findings.

A7 Quality Objectives and Criteria

All field and laboratory protocols will follow DES Limnology Center and Laboratory Services Standard Operating Procedures to ensure adherence to Quality Objectives and Criteria set forth in guidance documents from these two laboratories.

A8 Special Training/Certification

Table A-2 details special training for this study. The DES Project Manager will monitor field and laboratory personnel to ensure that proper procedures are carried out. Training will be documented with memos to the in house file, with a signature by the DES Project Manager as to when training was conducted.

Table A-2
Special Training Requirements

Project Function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Stream Stage Data Collection	Measuring stream stage	DES Project Manager, Amy Smagula	DES Limnology Center Interns and PPPA members	DES Limnology Center
Storm Event Sampling	Oral and written descriptions of procedures	DES Project Manager, Amy Smagula	PPPA members PPCAC members	DES Limnology Center

A9 Documents and Records

The Project Manager will be responsible for ensuring that appropriate project personnel have the most current approved version of the QAPP. The Project Manager will either provide electronic copies or hard copies of the latest version of the QAPP, upon its approval with the appropriate entities, and will follow up to ensure compliance with amendments to the QAPP.

Field sampling sheets and laboratory benchbooks will be used throughout the study to ensure appropriate data collection and sample analyses. Data from both field sheets and benchbooks will be entered into the Limnology Login-System. All data will be transferred into the EMD within 5 weeks of collection. Field parameters will be entered manually within 14 days of collection. Lab data will be transferred electronically within 14 days of analysis, and will be in the EMD within 5 weeks of individual sample dates.

Data summary statistics will be used to determine means, ranges, medians and standard deviations of data to compare with estimates predicted by the AVGWLF. Field and laboratory duplicates and replicates will be conducted for comparison with data sets. Acceptance criteria for samples are outlined in the DES Limnology Center and Laboratory Services SOPs. Field and laboratory data, once reviewed, will be used to calibrate the AVGWLF model to this watershed.

Data will be maintained in perpetuity in the EMD.

SECTION B: DATA GENERATION AND ACQUISITION SECTION

B1 Sampling Process Design (Experimental Design)

The table in Appendix D summarizes the frequency of sample collection and the numbers of samples for each of these parameters that has a field sampling component for model verification. Appendix E summarizes the field sampling methods for each activity.

Site Selection for Fixed Monitoring at Stream Gauging/Monitoring:
Tributary monitoring sites will be selected close to the lake edge to account for all inputs to streams from the watershed. Stations will be established far enough upstream from lake edge so as to avoid lake effects or back-flushing into the stream. SOPs for stream flow measurements are included in the Limnology Center SOPs. Duplicate field stream flow measurements will be conducted on each stream on each sample date. Stations will be monitored on a randomly selected day on a one day per week schedule. Samples collected from these sites will be analyzed for pH, turbidity, conductivity, TP, soluble orthophosphate, chloride, nitrate/nitrite, and conductivity according to the frequency indicated in Appendix D. Acceptance criteria for flow measurements are included in the Limnology Center SOPs.

Site Selection for Seepage and Interstitial Pore Water Sampling (IPWS):
Seven seepage and IPWS sampling locations will be established. Seepage locations will be selected based on development trends in the watershed, and will be representative of highly developed areas with older systems (n=5), and areas without systems or with few systems (n=2) to determine if any differences exist between the sites in terms of seepage contribution.

IPWS sampling will be conducted adjacent to the seepage meter locations following Limnology Center SOPs so they are representative of the water discharged from the meters. These samples will be analyzed for conductivity, TP, soluble orthophosphate, chloride, nitrate/nitrite, and conductivity according to the frequency indicated in Appendix D.

Precipitation/Temperature Data
Precipitation and temperature data will be obtained from a local weather monitoring station maintained by NH DES at the Lake Sunapee Dam.

Storm Event Monitoring:
Wet weather monitoring will be conducted three times during the study year (June 1, 2004 through August 31, 2005). Three storm event types will be selected (summer thunderstorm, long soaker, short low intensity storm). On days of forecasted rainfall, biologists and trained volunteers will staff each gauged monitoring station to collect samples of the first flush, rising limb, near peak, and falling limb for each of three types of storm events at each tributary. Flows and stage will be measured, and P samples, as well as other specificed parameters (see Appendix D) will be collected at each specified point during each storm.

All field data will be used to calibrate the AVGWLF to determine monthly nutrient loads to Perkins Pond, and to estimate nutrient loading to the pond for verification of the AVGWLF model output for present day nutrient loading.

B2 Sampling Methods

Field and laboratory sampling methods are detailed in the DES Limnology Center and Laboratory Services Standard Operating Procedures. Table B-1 summarizes the sample locations and requirements, and Table B-2 summarizes the measurement performance criteria for water samples on the pond.

Table B-1
Sample Locations and Requirements

Analytical Parameter	Collection Method	Sample Volume	Container Type and Size	Preservation Requirements	Max. Holding Time
Total Phosphorus	Surface Grab or Interstitial Pore Water Sample	250 mL	250 mL brown polyethylene	H_2SO_4 to pH<2, light protected, chilled to 4°C	28 days
Dissolved Reactive Phosphorus	Surface Grab or Interstitial Pore Water Sample	50 mL	50 mL centrifuge tube	Field filtered with 0.45 um filter and chilled to 4°C	24 hours unless frozen
Nitrate/Nitrite	Surface Grab or Interstitial Pore Water Sample	250 mL	1 L polyethylene	Chilled to 4°C, light protected	48 hours
Chloride	Surface Grab or Interstitial Pore Water Sample	1 L	1 L polyethylene	Chilled to 4°C, light protected	28 days
pH	Surface Grab	1 L	1 L polyethylene	Chilled to 4°C, light protected	24 hours
Conductivity	Surface Grab or Interstitial Pore Water Sample	1 L	1 L polyethylene	Chilled to 4°C, light protected	28 days
Turbidity	Surface Grab	1 L	1 L polyethylene	Chilled to 4°C, light protected	48 hours

Table B-2
Measurement Performance Criteria for Water Samples

Matrix	Analytical Parameter	Measurement Performance Criteria			QC Sample and/or Activity Used to Assess Measurement Performance
		Precision	Accuracy	Sensitivity	
Water	Conductivity [1]	RPD<20%			Field Duplicate
			+/- 10% @ 100 umhos		CCV
				</= 1/3 PQL	Annual MDL Calculation
		+/- 10%			Lab Duplicate
Water	Turbidity [1]	RPD<20%			Field Duplicate
			0-20 NTU +/- 1 >20–100NTU +/- 3 >100 NTU +/- 10		CCV
				</= 1/3 PQL	Annual MDL Calculation
		0-20 NTU +/- 1 >20–100NTU +/- 3 >100 NTU +/- 10			Lab Duplicate
Water	pH[1]	RPD<20%			Field Duplicate
			+/- 0.1 @ 6 pH		CCV
		+/- .5 pH Units			Lab Duplicate
Water	Total Phosphorus[3]	RPD<20%			Field Duplicate
		+/-0.004			Lab Duplicate
			<MDL		Reagent Blank
				</= 1/3 PQL	Annual MDL Calculation
			82-114%		Laboratory Matrix Spike
			+/-10% of 0.050		LFB
			+/-10% of 0.100		ICV
			+/-20% of 0.005		LCS
			r^2 >.995		Initial Calibration
			+/-20% of 0.005, +/-10% of 0.025, 0.050, 0.100, and 0.200		Calibration Verification Check
			+/-10% of 0.050		Continuing Calibration Verification
Water	Nitrate/Nitrite[2]				Field Duplicate
				<MDL	Blank
		Duplicate range= 0 – 0.036 mg/L			Duplicate Counts
Water	Chloride [2]	RPD<20%			Field Duplicate
				<MDL	Instrument Blank
		Range= 0-1.70 mg/L			Lab Duplicate
				<MDL	Reagent Blank
				0.23 mg/L	Annual MDL Calculation
			87-115%		Laboratory Matrix Spike
			Cal curve R^2 >/=0.995 RDL 3+/-20% Mid 100 and High 200 Stds +/-10%		Initial Calibration
			120+/-10%		Calibration Verification Check
			100+/-10%		Continuing Calibration Verification

1 NHDES Limnology Center
2 NHDES Laboratory Services

B3 Sample Handling and Custody

In the field: Sample bottles are labeled in the field with water body, name/town, sample location, sample date, sample time, and the collector's initials. No numbers are assigned to the field samples unless replicates are being collected, in which case an ordinal system (#1, #2, etc.) is used to indicate the samples and the order in which they were taken. Water samples will be placed on ice in a cooler immediately after collection and transported to DES for analysis by the sample collector, per SOPs laid out in the DES Limnology Center SOPs.

In the Limnology Laboratory: Samples are logged into a computer database system that prints out a label for each logged sample. The label contains information such as water body name/town, sample location, sample date, sample time, collectors' initials, log-in date and time, and the parameters to be run on the sample.

This login system also assigns a number to the sample, which is tracked through both the Limnology Center Laboratory and the Laboratory Services Unit. These numbers are assigned in consecutive order in a database as samples are logged in, starting with the year, followed by the sample number in the system (e.g., 2001-XXXX).

All samples are kept at 4^{o}C in the field and between laboratories. In the Limnology Center, samples are warmed to 25^{o}C for analysis according to DES Limnology Center SOPs.

When samples are transferred to the Laboratory Services Unit they are listed on a transfer sheet by station location, sample number, matrix (surface water/groundwater/etc), and analytical parameter. An area for signing off for custody is included on the lab sheet.

Figure B-1 summarizes the sampling handling, tracking, and custody channel that all samples go through. The Limnology Center personnel, supervised by Andy Chapman, the QA/QC officer for the laboratory (Rachael Rainey), conduct sample archival activities. Sample disposal is down the sink (most are just surface water lake samples) unless otherwise specified in the DES Limnology Center SOPs.

Figure B-1
Sampling Handling/Tracking/Custody Summary Flow Diagram

Field Collection
⇩
Laboratory drop-off to Limnology Center
⇩
Limnology Center log-in and field sheet collection

⇙	⇘
Sample Analyses	Chemistry Lab login
⇩	⇩
Record data	Analyze/Record data
⇩	⇩
Sample disposal	Sample disposal

B4 Analytical Methods

Analytical methods for sampling are included in Appendix E. If failures in the analytical system occur, the Andrew Chapman or Rachael Rainey will be notified and samples will be flagged as questionable, as appropriate.

B5 Quality Control

Quality control activities for both field sampling and laboratory analyses are detailed in the Limnology Center and Laboratory Services SOPs.

B6 Instrument/Equipment Testing, Inspection, and Maintenance

Equipment, supplies, and sample containers will be examined by the project manager prior to use. Criteria for rejecting or accepting the materials are specified in the DES Limnology Center and Laboratory Services Standard Operating Procedures. Extra sample supplies and containers will be brought to field sites in the event that contamination or damage of another container occurs. Table B-3 summarizes the equipment inspection and maintenance activities.

Table B-3
Equipment Inspection and Maintenance

Equipment	Maintenance Activity	Testing/Inspect Activity	Responsible Person	Frequency	Acceptable Criteria	Corrective Action
pH meters	Change pH probe	Check probe for cracks and gel level	Analyst	Prior to each use	Calibration	Replace probe
Turbidity meters	Change sample cell	Inspect cell for scratches	Analyst	Prior to each use	Scratch free sample cell	Replace cell
Conductivity Meters	Change conductivity probe	Inspect probe for flaking	Analyst	Prior to each use	Calibration	Replace probe
Flow Meter	Change batteries	Inspect cables and sensors	Analyst	Prior to each use	Calibration	Clean probe, replace cables
Peristaltic Pump	Charge internal battery, replace worn fuses	Check charge	Analyst	Prior to each use	Charged	Charge or change fuse

B7 Instrument/Equipment Calibration and Frequency

Instrument and equipment calibration and frequency are detailed for both field and laboratory sampling in the Limnology Center and Laboratory Services Unit SOPs.

B8 Inspection/Acceptance of Supplies and Consumables

The QA/QC Officer (Andrew Chapman) will inspect and accept/reject supplies and consumables as needed.

B9 Non-direct Measurements

The table in Appendix A lists those items that will not be directly measured during the study (indicated with the word 'Default' and shaded in light gray). The variables for these specific parameters will be selected from default values from the AVGWLF model software.

B10 Data Management

All raw data will be entered by DES into EMD.

Data from parameters analyzed in the DES Limnology Center will be entered immediately upon analysis into meter-specific bench books. These data will then be entered daily into the Limnology Center database, and electronically transferred to EMD after passing Quality Assurance review, which involves verficiation of data with bench book entries. Data analyzed in the DES Laboratory Services Unit will be electronically entered into the EMD upon completion of the analyses. Laboratory login sheets and custody sheets are returned as well.

Field recordings will be made in ink. No data are being collected in this project for legal proceedings, therefore there are no set procedures for recording data.

Field sample data collection sheets are included in Appendix E.

SECTION C- ASSESSMENT AND OVERSIGHT

C1 Assessments and Response Actions

Field Sampling deviations and project deficiencies determined during the field sampling will be evaluated for source of deviation and corrected with verbal communications in the field. Any necessary written/structural changes will be made through a revision of the SOP for that activity. Field sampling activities will be monitored by the DES Project Manager to determine compliance.

DES Limnology Center Fixed Laboratory TSA-QAPP deviations and project deficiencies determined during the Limnology Center fixed laboratory TSA will be addressed immediately. Replicates and critical range tables will be checked with data to determine if sources of error exist. Data will be entered into the computer weekly and cross-referenced with bench books for accuracy. Any deviations in results will be addressed in both written and verbal formats, and future sampling will be monitored to verify that compliance is reached.

DES Laboratory Services Fixed Laboratory TSA-QAPP deviations and project deficiencies determined during the DES Laboratory Services fixed laboratory TSA will be addressed immediately. Replicates and critical range tables will be checked with data to determine if sources of error exist. Data will be entered into the computer weekly and cross-referenced with bench books for accuracy. Any deviations in results will be addressed in both written and verbal formats, and future sampling will be monitored to verify that compliance is reached. Checklists for use in assessing sampling activities and field and/or lab analytical activities will be used to evaluate both in-house and volunteer activities. Copies of these will be included with the final report.

Corrective actions will be implemented any time that deviations or errors are noted in field and laboratory work during the project.

C2 Reports to Management

Weekly reviews of data will be conducted to determine sampling quality and efficiency. These reviews will be checked by the QA Project Officer (Andrew Chapman), and notifications regarding questionable data will be relayed to the Project Manager.

SECTION D: DATA VALIDATION AND USABILITY

D1 Data Review, Verification and Validation

Please reference the DES Limnology Center and Laboratory Services SOPs for criteria used to review and validate data. Copies of these documents are available both electrnically and in hard copy upon request.

D2 Verification and Validation Methods

Data validation will occur weekly with laboratory QA/QC activities through the detailed examination of raw data to check for calculation and transcription errors. Data of known and documented quality will be provided from this examination. Results from this analysis will be transferred to data users through Andrew Chapman.

Verification

Table D-1 describes the process that will be followed to verify and validate data.

Table D-1
Data Verification Process

Verification Task	Description	Responsible for Verification
Field Data/Field Notes	Field data sheets will be collected at the end of each sampling event and analyzed for completeness and accuracy.	Amy P. Smagula DES
DES Limnology Center Data	These data will be subject to a 10% replicate and critical range analysis in the lab. The QA/QC officer will check the accuracy of these samples. Lab personnel will conduct data entry and comparison to bench book data. The Perkins Pond analyses are part of the total Limnology Center analyses which are subject to 10% laboratory duplicates.	Andy Chapman DES Laboratory Personnel DES
DES Laboratory Services Unit Data	Data generated in this laboratory will be checked by the laboratory QC personnel and then transferred to the Limnology Database where it will also be checked by the project manager.	Rachel Rainey DES Laboratory Services Amy P. Smagula DES
AVGWLF Model Calibration and Loading Preditions	Data entered into the model will be checked prior to running the model for each of the various scenarios.	Ken Edwardson and Amy Smagula DES
Final Report Data Analyses and Recommendations	The final project report will be analyzed for content, accuracy, and for types of recommendations made for problems found during the data acquisition phase of the study.	Jody Connor, Robert Estabrook, and Paul Currier DES

Validation

Table D-2 summarizes which sampling, handling, field analytical and fixed laboratory data will be validated.

Table D-2
Data Validation Summary Table

Medium/ Matrix	Analytical Parameter	Data Validation (Name, title and organizational affiliation)	Responsibility for Data Validations (Name, title and organizational affiliation)
Surface Water/GW	Total Phosphorus Dissolved Phosphorus Nitrate/Nitrite and Chloride	Rachel Rainey DES Laboratory Services 603-271-2993	Amy P. Smagula DES 603-271-2248
Surface Water/GW	PH	Amy P. Smagula DES 603-271-2248	Andy Chapman DES QA/QC Officer 603-271-5334
Surface Water/GW	Turbidity	Amy P. Smagula DES 603-271-2248	Andy Chapman DES QA/QC Officer 603-271-5334
Surface Water/GW	Conductivity	Amy P. Smagula DES 603-271-2248	Andy Chapman DES QA/QC Officer 603-271-5334
GW	Seepage Data	Amy P. Smagula DES 603-271-2248	Andy Chapman DES QA/QC Officer 603-271-5334
GW	IPWS	Amy P. Smagula DES 603-271-2248	Amy P. Smagula DES 603-271-2248
Surface Water	Flow	Amy P. Smagula DES 603-271-2248	Amy P. Smagula DES 603-271-2248
Temperature	Temperature	Amy P. Smagula DES 603-271-2248	Amy P. Smagula DES 603-271-2248
Precipitation	Total Phosphorus and Dissolved Phosphorus	Amy P. Smagula DES 603-271-2248	Amy P. Smagula DES 603-271-2248

D3 Reconciliation with User Requirements

Preliminary Data Review

Data will be reviewed for completeness throughout and at the end of the field study. An evaluation of data completeness will be throughout the study, and again at the end for the whole data set.

Sample Representativeness

Field sampling SOPs will be strictly adhered to. If variation in sample results occurs, stream bracketing or repeat sampling may take place to ensure that samples are representative.

APPENDIX A

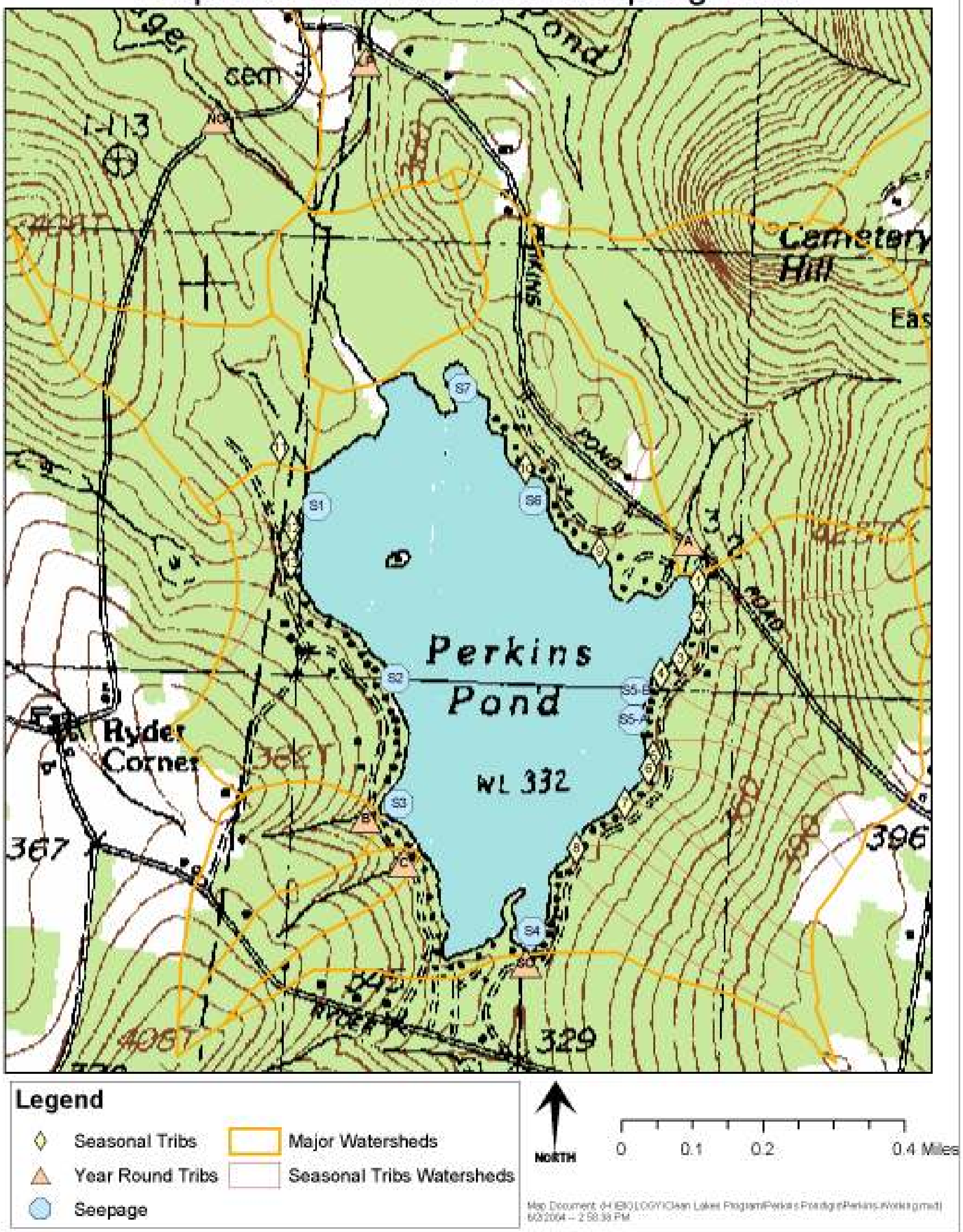
GENERALIZED WATERSHED LOADING FUNCTION (GWLF) MODEL PARAMETERS

FILE TYPE	**CHARATERISTICS**	**Range of values**		
		MIN	**MAX**	**UNITS**
WEATHER.DAT file				
	Historical weather data from National Weather Service monitoring stations	**-25**	**100**	**degrees**
		-25	**100**	**degrees**
		0	**15**	**inches**
TRANSPORT.DAT file				
Basin size	GIS/derived from basin boundaries	**0.027**	**3.639**	**sq-miles**
Land use/cover distribution	GIS/derived from land use/cover map	**Many Types. Hand Built.**		**sq-miles**
Curve numbers by source area	GIS/derived from land cover and soil maps	Calculated		
USLE (KLSCP) factors by source area	GIS/derived from soil, DEM, and land cover			
		0.1	0.28	
				miles
		na	na	
ET cover coefficients	GIS/derived from land cover	0	1	ratio of ET by cell
Erosivity coefficients	GIS/ derived from physiography map	0.07	0.13	ratio of ET by cell
Daylight hrs. by month	Computed automatically for state	9.0	15.0	hours
Growing season months	Input by user	May to October		
Initial saturated storage	Default value of 10 cm	Default		cm
Initial unsaturated storage	Default value of 0 cm	Default		cm
Recession coefficient	Default value of 0.1	Default		coeff
Seepage coefficient	Default value of 0	Default		coeff
Initial snow amount (cm water)	Default value of 0	Default		cm
Sediment delivery ratio	GIS/based on basin size	0.2	0.35	ratio
Sediment A Factor	GIS - Calculated			
		Calculated		
		na		
		Calculated		
		Calculated		
		Calculated		
Soil water (available water capacity)	GIS/derived from soil map			
Lateral Erosion Rate				
		Calculated		%
		na		AEUs
		Calculated		
		Calculated		coeff
		Calculated		L/L
NUTRIENT.DAT file				
Dissolved N in runoff by land cover type	Default values/adjusted using AEU density			
Dissolved P in runoff by land cover type	Default values/adjusted using AEU density			
N/P concentrations in manure runoff	Default values/adjusted using AEU density	**na**	**na**	
N/P buildup in urban areas	Default values (from GWLF Manual)			
N and P point source loads	GIS/derived from NPDES point coverage			
Background N/P concentrations in GW	GIS/derived from new background N map			
Background P concentrations in soil	GIS/derived from soil P loading map			
Background N concentrations in soil	Based on map in GWLF Manual			
Months of manure spreading	Input by user			
Population on septic systems	GIS/derived from census tract map	**350**	**500**	

APPENDIX B

PERKINS POND SAMPLING SITES

Proposed Perkins Pond Sampling Sites



APPENDIX C

SANITARY SURVEY FORM

Perkins Pond Shorefront Lot Survey and Interview Form

Current Owner:____ Tax Map #:_______________

Owner's Address: ______________________________________ Lot #: ___________________

Name of Original Owner (if applicable): ____

Name of person interviewed, if not the owner: ____

Property Address: ____

Sewage Disposal System Type

Septic Tank and Leach Field or Trench	☐	Chemical Toilet	☐
Cesspool	☐	Gas Toilet	☐
Sealed Holding Tank	☐	Privy	☐

Other:

Comments:

Age Of System Years: __________ Date System Built: __________

Approval Date: __________

System Loading

Number of Bedrooms: __________

months occupied/year: __________

Average # of Occupants: Spring:__________ Summer: __________

Fall: __________ Winter: __________

Approval #: ________________________

System Capacity __________(G.P.D.) ______________(tank size)

Leach field size: __________ft X __________ft

Distance above seasonal high water: __________ft

New System or Replacement System (circle one)

Conditions of the System:

poor fair good excellent

Any Violations:

System Maintenance (specify on tank, leachfield or other)
Repairs: ____________________

Replacement: ____________________

Date of Latest Septic Tank Pumping: ____________________

Average Frequency of Tank Pumping: ____________________

Water Supply Source

Town System ☐ Lake ☐
Dug or Surface Well ☐ Off-lot Well/Spring ☐
Bottled Water ☐ Drilled Well ☐

Water Consumptive Appliance Data
# of Toilets: __________
# of Showers/bathtubs: __________ Indoor: __________ Outdoor: __________
# of Wash Basins:

Dish Washer: Yes ☐ No ☐ *Clothes Washer*: Yes ☐ No ☐ *Garbage Disposal*: Yes ☐ No ☐
Water Softener: Yes ☐ No ☐ Other:

Property Data
Lake Frontage: Feet: __________ Lot Dimensions: __________ft X __________ft.

Acreage: __________

Building area: __________sq ft. Paved area: __________sq ft

Lawn area: __________sq ft Natural area: __________sq ft

Soil Type(s) (from County Soil Maps/GIS): ____________________

Depth to Bedrock: __________ft

Lateral Distance of leachfield to Pond: __________ft

GPS File Name (if applicable):

Draw a sketch of buildings, set-back distances of each to lake shore, distance of sewage disposal system to nearest surface water and lake, including leach field, etc. Use attached lot map for drawing.

APPENDIX D

SAMPLING PARAMETERS AND FREQUENCY

APPENDIX E

FIELD SAMPLING PARAMETERS

STANDARD OPERATING PROCEDURES

STANDARD TRIBUTARY FIELD SAMPLING PROCEDURES

When NOT To Sample:

1. **Do not** sample water that is not flowing. Stagnant water sampling will result in values that are not representative of the water entering or leaving the lake.
2. **Do not** sample an area where the bottom sediments have been recently disturbed. If you must wade into the water, take the sample in an undisturbed upstream area. Sediment particles in a sample will complicate and sometimes invalidate laboratory analysis.

When To Sample:

1. Sample water that is flowing **only**. Even at low flow you are likely to see clues that water is moving. Submerged aquatic vegetation leaning in a downstream direction and surface debris moving gently downstream are good indicators of flowing water.

How To Sample:

*If bacteria samples are to be collected, see below. Bacteria samples **must** be taken first and with caution so as not to contaminate the sample.*

1. Ensure that both a white 1000 mL bottle & a brown 250 mL bottle preserved with acid are properly labeled with lake name, town, location, date and sampler's initials.
2. Dip the white bottle into the flow to obtain a sample of rinse water. Try to avoid catching surface debris.
3. Cap the bottle, shake and discard rinse water **downstream**.
4. Refill the white bottle and pour the sample into the brown bottle. The brown bottle contains acid and will burn skin & dissolve clothing, so please be careful not to spill the acid or overflow the bottle. It is recommended that you wear safety glasses and disposable gloves when dealing with the brown bottle containing acid.
5. Top off the white bottle.
6. Store all samples in a cooler with ice and return to the Concord or Sunapee laboratory within 24 hours. Remember, laboratories have limited hours during the week. Please call in advance to notify the labs of your sampling date.

Taking Bacteria Samples:

1. A sterile (indicated by a dated sticker) 250 mL bottle must be labeled as above.
2. Aseptically remove the cap, making sure not to touch the inside of the cap and bottle.
3. Point the mouth of the bottle down towards the water's surface.
4. Using a continuous "U-shaped" motion, thrust the bottle under the water's surface and fill in one continuous upstream motion. In this fashion, the water will flow into the bottle, then over your hand. If sampled in a downstream fashion, the water would flow over your hand then into the bottle causing contamination from the sampler.

3. Place sample in a cooler with ice, and submit to the laboratory as soon as possible. Samples turned in on Friday must be submitted well in advance of closing time to allow time for pre-weekend analysis.

Standard Operating Procedure for Stream Flow Determinations

Equipment: Marsh-McBirney Model 2000 Flo-Mate, Flow field sheet
Velocity Measurement: Electromagnetic
Zero Stability: +/- 0.05 ft/sec
Accuracy: +/- 2% of reading + zero stability
Range: -0.5 to +19.99 ft/sec (-0.15 m/sec to 6 m/sec)

Calibration:
1. Turn meter on and look for 'low battery' display. If display does not come on, proceed as follows. If light comes on, change batteries, then proceed with the following procedures.

2. Set meter reading to 'fixed point averaging' for a 30 second interval. Do this by simultaneously pressing the up/down arrows to toggle to the FPA display. Set the averaging time to 30 seconds by using the up arrow.

3. Fill bucket with water from stream. Insert probe into bucket, clear meter reading, and check for zero reading (no flow should be going on in bucket, thus zero reading).

Measuring Stream Channel Flow:
1. Select an area of the stream in which to flow (area near staff gauge is usually selected)

2. Stream bottom should be relatively flat and free of obstructions (large rocks, plants)

3. Measure the width of the stream from bank to bank using a measuring tape. Record width of stream of flow sheet below name of stream or sample location.

4. Using the measuring tape, break the stream width into equal segments (6 inches,1-foot, 2-foot)

5. Take a depth reading at each interval across the stream, starting at bank one and ending at bank two. Record these depths on the flow sheet.

6. Next, take fixed point averaged flow readings (this is the 30 second average) in between each point where depth was measured. This is done by placing the flow probe into the stream, facing into the direction of flow. Probe should be 1/3 of the way down from the surface of the stream, and 2/3 of the way above the sediments. Record flow reading on flow sheet between the two recorded depth readings. Continue until flow readings are collected for entire stream segment.

7. Take a reading off the staff gauge in the stream, recording this number in the appropriate column on the field data sheet.

Measuring Stream Flow from a Culvert:
1. Find downstream end of culvert

2. Using a yardstick or other measuring device, take a depth reading in the center of the culvert invert. Record this on the field data sheet.

3. Next, take a measure of the width of the entire culvert. Record this on the data sheet.

4. Next, place the flow probe into the flow of the water in the center of the culvert invert. Take a fixed point averaged flow reading as described above. Record in appropriate column on field data sheet.

5. Take a reading off the staff gauge in the stream below the culvert, and recordin in appropriate column of the field data sheet.

<u>Calculating Stream Channel Discharge:</u>

1. Back in the laboratory, open the lab calculation software on the computer. Double click on Flow.exe icon.

2. Answer the questions as you go through the blue dialog box choices.

3. Are you depths in inches or feet- TYPE 'F' FOR FEET

4. Which meter did you use- TYPE 'M' FOR MARSH MCBIRNEY

5. Are your flows in feet, meters, or centimeters/second- TYPE 'F' FOR FEET PER SECOND

6. Enter number of intervals (this is the number of stream width segments at the point that you conducted the flow, ie, how many flow readings did you take---count them on the field data sheet). TYPE IN THE NUMBER OF INTERVALS AND PRESS ENTER.

7. Next you will see a screen where you will enter your flow data from your field sheet. Width is the width of the stream segment that you broke the entire channel width into (ie, 6 inches/1-foot, 2-foot). TYPE IN THE WIDTH AND PRESS ENTER. Velocity is the flow meter reading in f/s. TYPE IN THE FLOW READING AND PRESS ENTER. Number of depths is the depth readings surrounding where you took the flow reading (the one before and the one after). There will usually be 2. TYPE IN THE NUMBER OF DEPTH READINGS AND PRESS ENTER. Finally, it will ask you flow the depth readings. ENTER THE DEPTH READINGS FROM YOUR FIELD SHEET AND PRESS ENTER AFTER EACH.

8. Once you have completed one line it will automatically switch you to line two. Enter the next set of data from that stream, continuing this process until all data are entered for that stream.

9. Next, at the bottom of the blue dialog box you will be asked if you want to accept what you have entered, or if you want to change data. You will not be allowed to change data during the first entry. Now is the only time you can change mistakes. ENTER 'A' TO ACCEPT OR 'C' TO CHANGE DATA.

10. When you choose 'A', the screen will switch and give you the 'Result of your calculation' in cubic feet per second, your stream discharge for that point in the stream. Enter this number onto your field data sheet.

Calculating Culvert Discharge:

1. Double click on the Lotus 'Shortcut to Culverts' icon.

2. This spreadsheet will calculate culvert discharge. The top group of calculations will calculate flow for culverts where water is going directly through the culvert. You will use this one most of the time. The bottom set of equations is for when water is breaching culvert headwalls or circumventing the culvert.

3. Where it asks for culvert width- ENTER CULVERT WIDTH MEASUREMENT IN INCHES AND HIT DOWN ARROW

4. Where it asks for depth of water- ENTER DEPTH OF WATER IN INCHES AS MEASURED FROM CENTER OF CULVERT INVERT AND HIT DOWN ARROW

5. Where it asks for flow- ENTER FLOW IN FEET/SEC AS MEASURED WITH FLOW METER AND HIT DOWN ARROW

6. Discharge is automatically calculated. RECORD THE DISCHARGE IN CFS ON FIELD DATA SHEET IN APPROPRIATE COLUMn.

STANDARD OPERATING PROCEDURES
INTERSTITIAL PORE WATER SAMPLING FOR TOTAL PHOSPHORUS

A. Sampling Methodology

1. **Preservation:** 0.5 ml sulfuric acid
2. **Holding Time:** 28 days
3. **Required Volume:** 250 mls
4. **Container Type:** Amber polypropylene

B. Data Collection

Interstitial pore water samples will be collected from the vicinity of the established seepage meter locations in the lake. Six locations will be established in sandy subtrates around the perimeter of the lake.

1. Connect peristaltic pump to IPWS probe with rubber tubing
2. Pump 250 mls of deionized water through probe to clear lines
3. Insert steel IPWS probe into sediments to a depth of approximately 0.5 meters.
4. Turn on peristaltic pump and pump sample into 250 mls amber bottle until full (do not overflow).
5. Cap and store bottle on ice.
6. Return sample to laboratory and analyze in Laboratory Services Unit per specified total phosphorus method in Appendix C.

STANDARD OPERATING PROCEDURES
SEEPAGE METER SAMPLING

A. Equipment

- 7 seepage meters (made out of the top and bottom 1/3 portions of 55 gallon steel drums)
- 7 spickets inserted and sealed into tops of barrels
- Rubber tubing
- 7 stopper plugs with attached bags
- Steel clamps
- Graduated cylinder

B. Meter Installation

1. Dig meters into ~3-foot depth water zone in lake, into sandy substrate
2. Place meters so that near shore side is higher than lake side of meter (so that meter is on an angle with the slope of the substrate
3. Compress edges of meter into sediment so that the bottom rim of the meter is completely pressed into sediments
4. Allow to equilibrate with surroundings for at least two weeks

C. Sample Collection

1. Select a starting location (Meter #1)
2. Pour 100 measured mls of lake water into bag through tube.
3. Fit clamp over tube and squeeze all air from the bag (do not allow water to escape). Tighten clamp.
4. Fit tube end of collection bag over the spicket of the seepage meter, release clamp, and note time. Record time on data sheet.
5. Continue as in steps 1-4 for remaining meters in lake.
6. Allow at least one hour to pass until returning to Meter #1.
7. Re-clamp tube on the bag now attached to meter.
8. Note time and record on data sheet.
9. Carefully remove tube from meter spicket.
10. Unclamp tube and pour contents of bag into graduated cylinder and measure volume. Record on field data sheet.

D. Seepage Calculation

Calculate seepage contribution to lake per methods outlined in Appendix F.

Stream Flow Measurements

Project:				By:	Date:
Culvert (D) or Stream Width	Distance From Bank	Depth	Flowmeter velocity (f/s)	Calculated flow (cfs)	Comments/Staff Gage

DATE:______________

Seepage
Perkins Pond, Sunapee

Station #	$T_{beginning}$	T_{stop}	FV*
1	___________	___________	___________
2	___________	___________	___________
3	___________	___________	___________
4	___________	___________	___________
5A	___________	___________	___________
5B	___________	___________	___________
6	___________	___________	___________
7	___________	___________	___________

* final volume including 100 ml of lake water
** facing shoreline, A is meter on left

Notes/Comments: